Upgrade and Temperature Studies of the MDT Front-end Electronics of the LMU Cosmic Ray Facility test stand

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ATLAS MUON WEEK

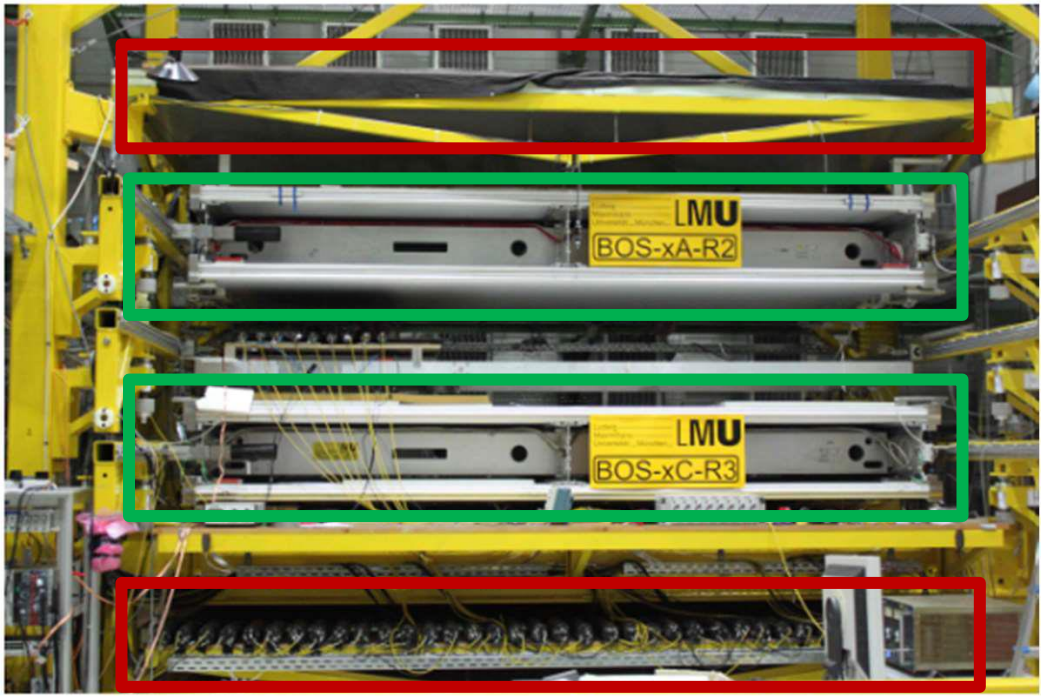
FSP ATLAS
Erforschung von
Universum und Materie

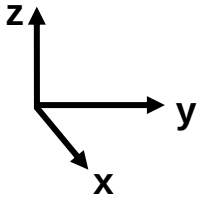
Cosmic Ray Facility (CRF)

- Detector system consisting of:
  1. 2 spare MDT BOS chambers
  2. Scintillators used for triggering on the top and bottom
  3. Iron absorber for a hard cut on low energy muons (~600 MeV)

- Tracking in:
  1. Precision (x-dir.) from the MDTs
  2. Coarse (y-dir.) from the scintillators

- Readout paths:
  1. CSMs and mezzanine cards for the MDTs using legacy FILAR
  2. VME for scintillators



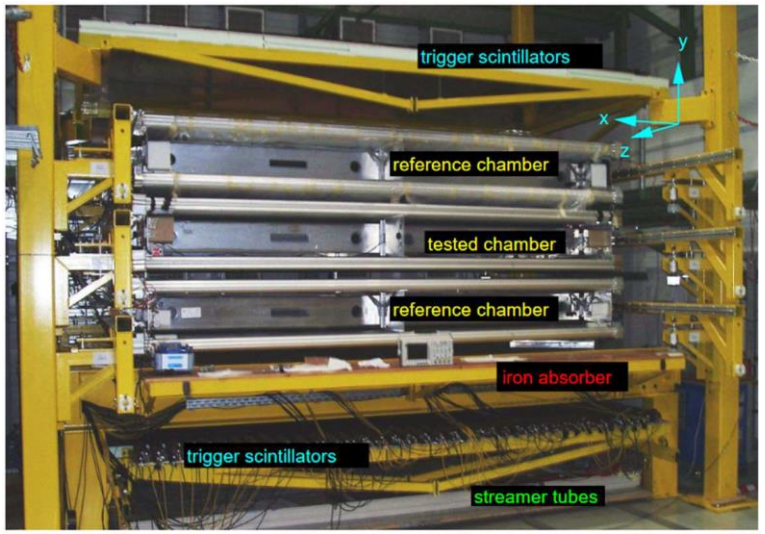


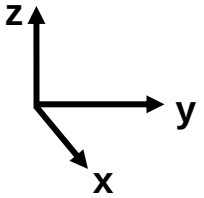
Cosmic Ray Facility (CRF)

- In the past:
  1. Testing and commissioning of the series production of the MDT-BOS
     Δx ~ **8 µm**; Δz ~ **25 µm**

  2. Testing and commissioning of the series production of the NSW-MM detectors
     Strip calibration ~ **30 µm**

- Present:
  1. Upgrade to ATLAS phase-II MDT front-end and backend electronics for a full slice test

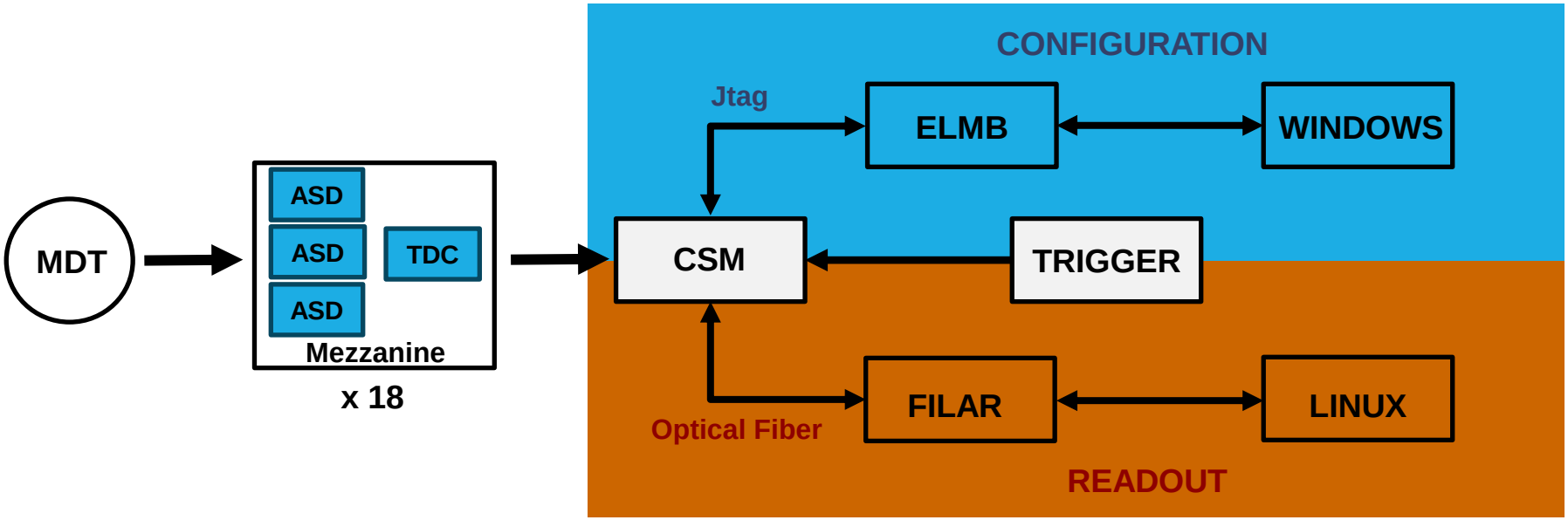




The old CRF MDT Electronics

- Outdated readout electronics

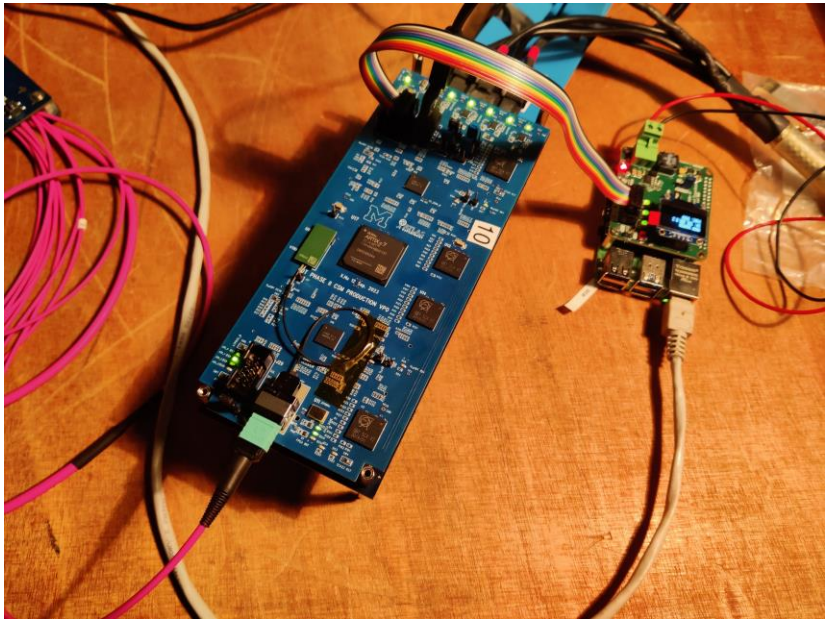
- Differences to the phase-II front-end electronics:
  1. Legacy mezzanine cards
  2. Old CSM
  3. FILAR readout cards



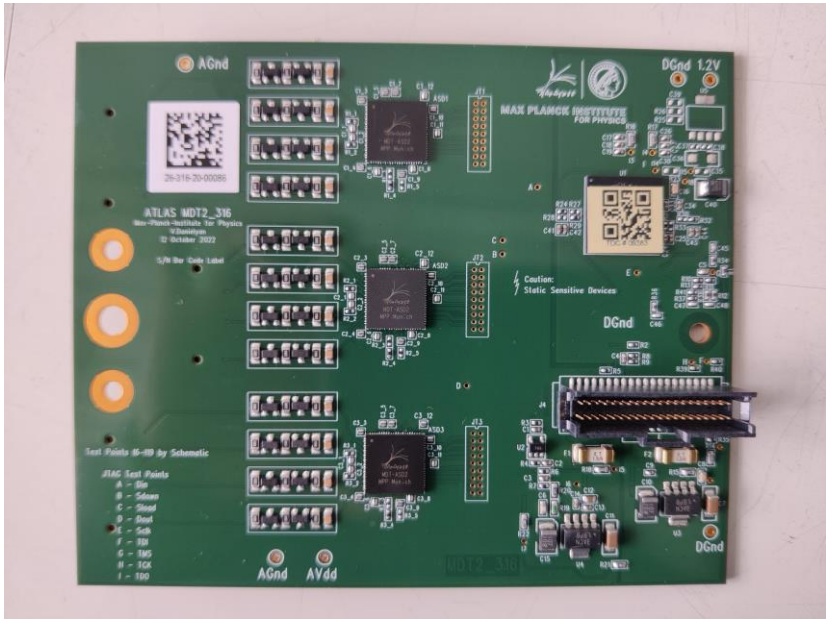
Upgrade to Phase-II MDT Electronics

- Changes made:
  1. Legacy mezzanine cards → new flat mezzanine cards (MDT316) x 10
  2. Old CSM → new CSM
  3. FILAR card → MiniDAQ board

New CSM

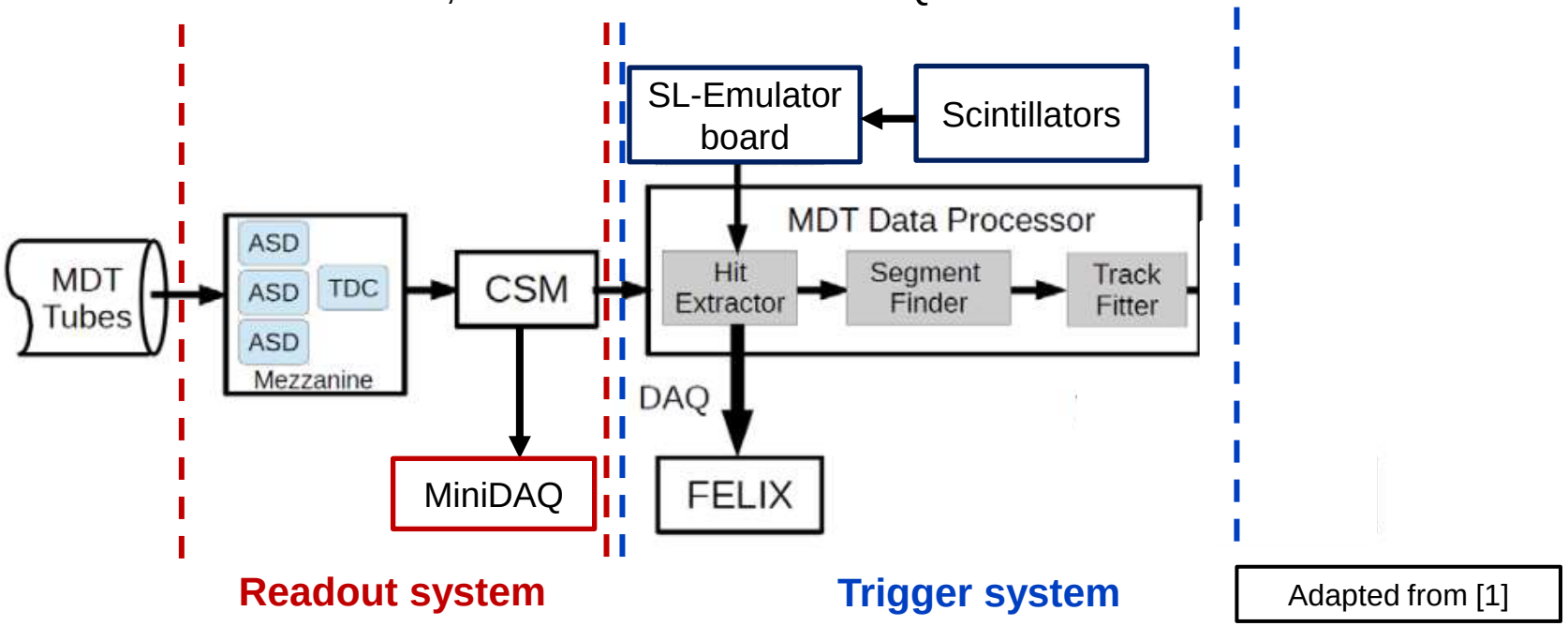


New MDT316 cards (x10)



Upgrade to Phase-II MDT Electronics

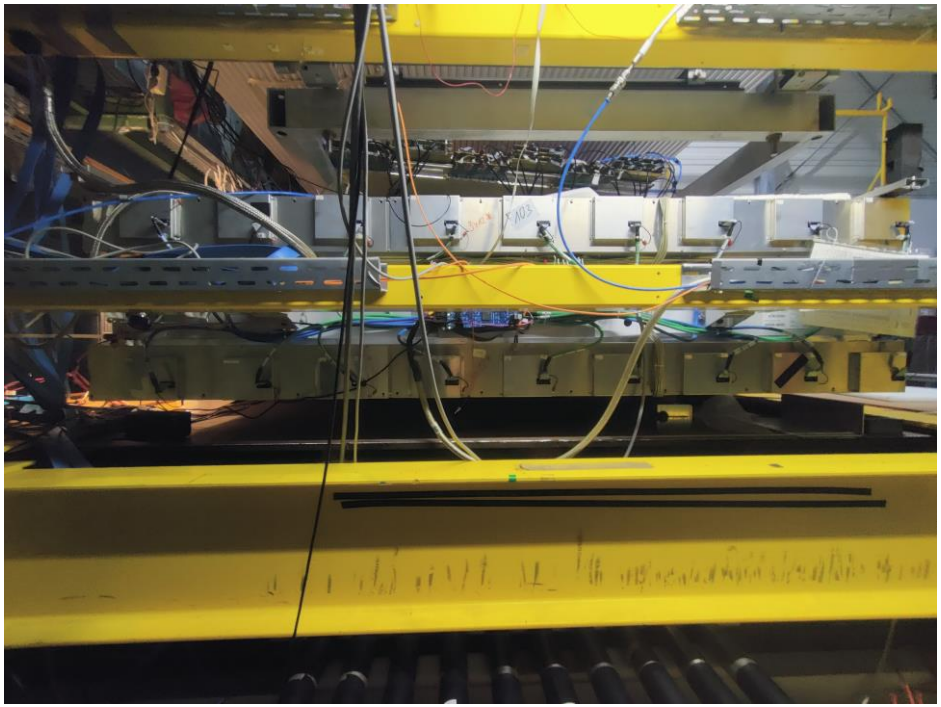
- The trigger (covered in the next talk by N.Schneider) and readout systems will be upgraded to Phase-II electronics
- FELIX still needs to be tested; alternative used: MiniDAQ board

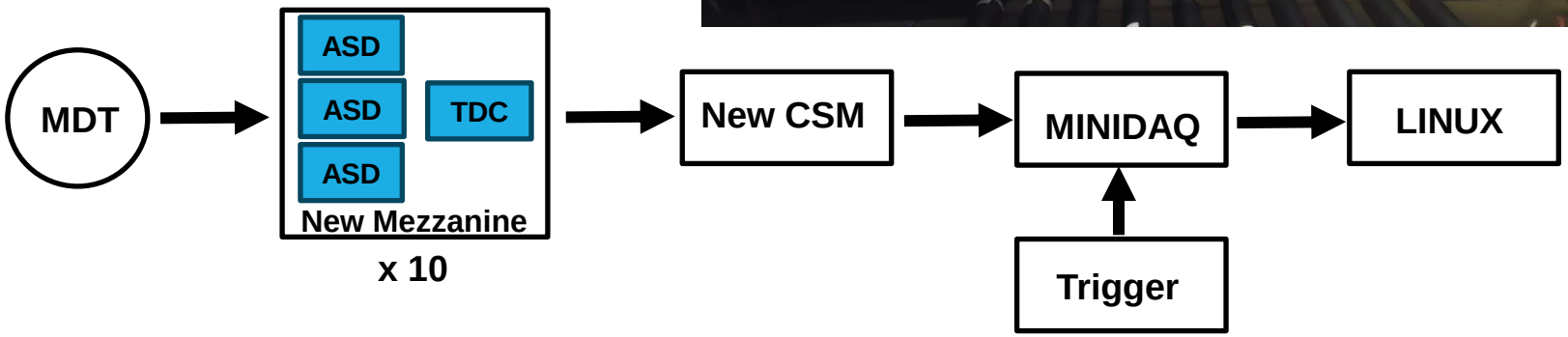


[1]. Upgrade of the ATLAS Muon Drift Tube Front-end Electronics for HL-LHC Runs, X. Hu, University of Michigan (2020)

Test Set-up

- HV of MDTs set to 3080 V
- Gas used: Ar:CO_2
- MiniDAQ and CSM configuration successfully completed (many thanks to Yuxiang for the support!)
- One chamber completely replaced with 18 MDT316 cards and new CSM and connected to MiniDAQ

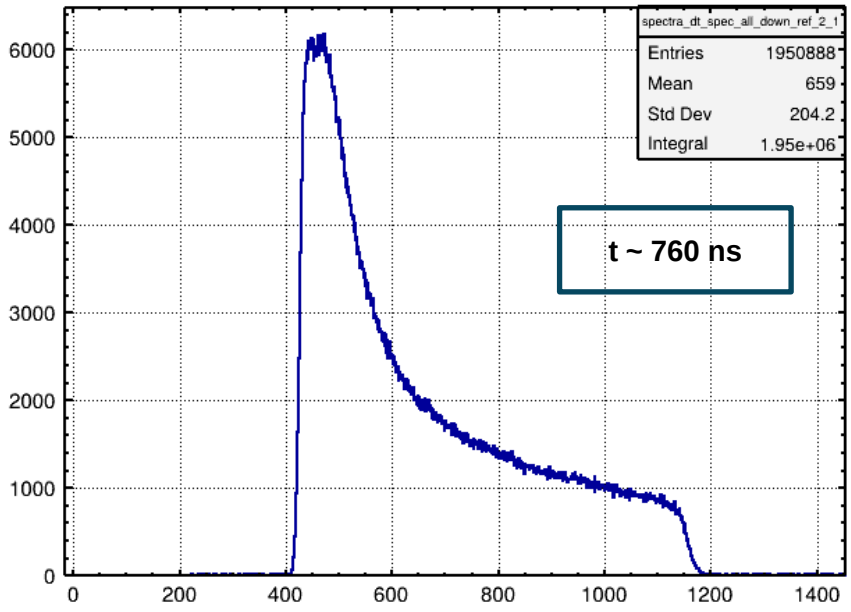


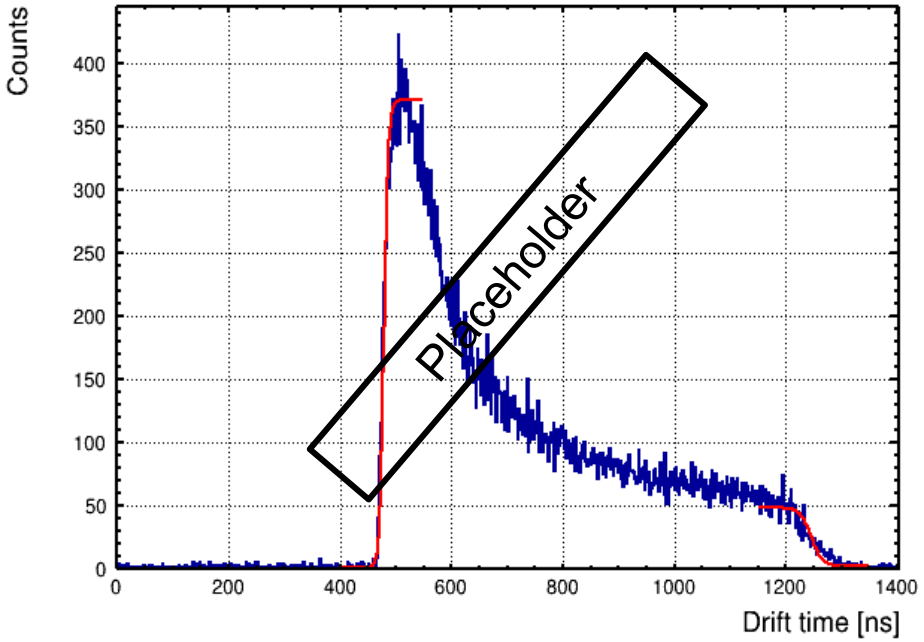


Data Comparison: TDC Spectra

Old TDC of 144 tubes (6 mezz.,1 multilayer)

New TDC of 24 tubes (1 mezz., same multilayer)

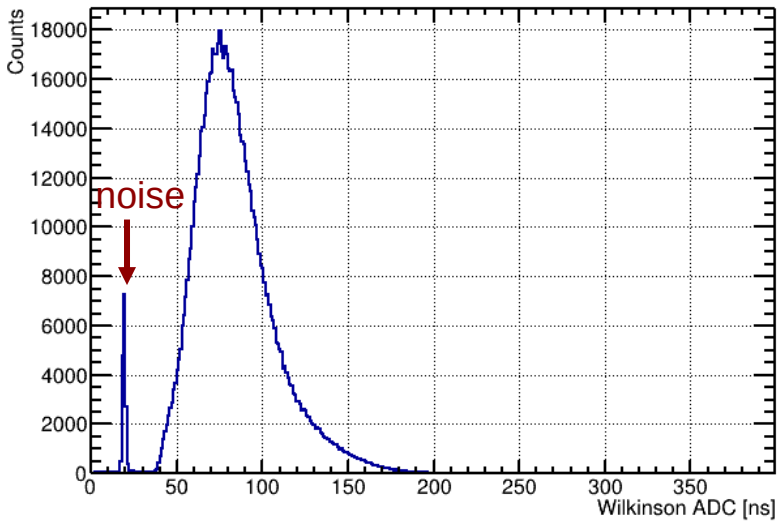




Trigger matching performed inside the MiniDAQ FPGA

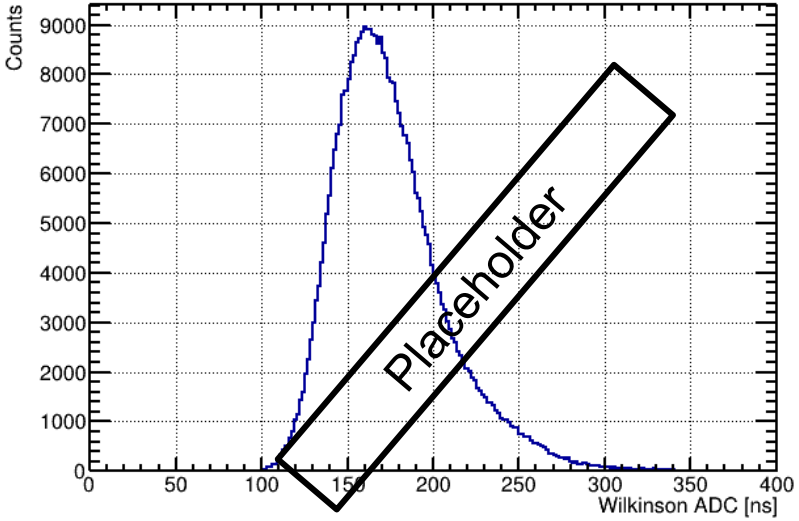
Data Comparison: ADC Spectra

Old ADC of 144 tubes (6 mezz., 1 multilayer)



- ADC Threshold: -38 mV
- Wilkinson Gate Width: 14 ns
- Rundown current: 4.5 µA
- Hysteresis: 8.75 mV

New ADC of 24 tubes (1 mezz., same multilayer)

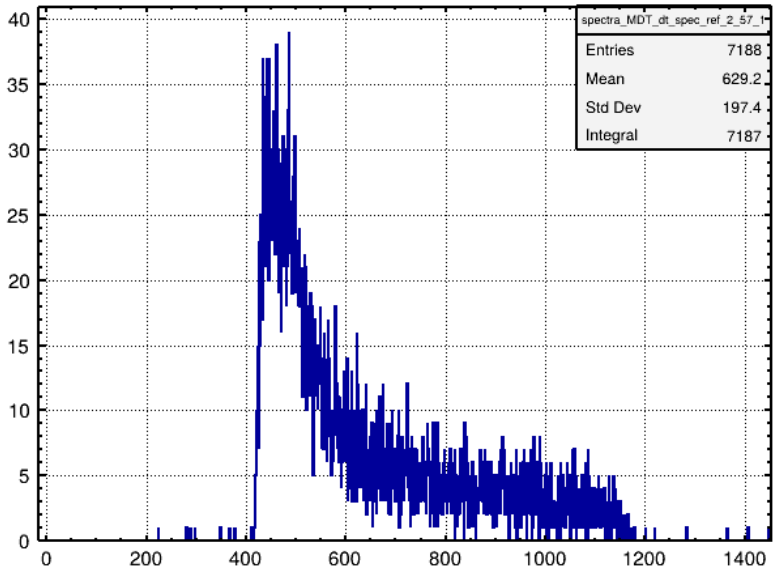


- ADC Threshold: -39 mV (code 108)
- Wilkinson Gate Width: 14 ns (code 2)
- Rundown current: 4.5 µA (code 3)
- Hysteresis: 8.75 mV (code 7)

Data Comparison: TDC Spectra

Old TDC of 1 tube

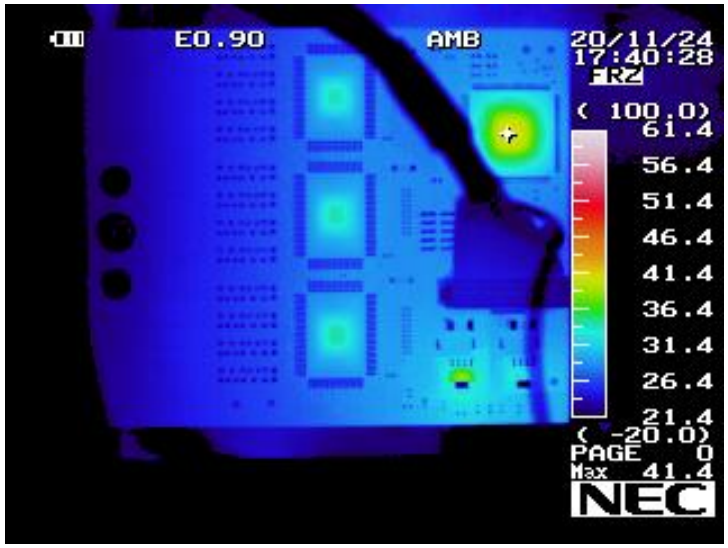
New TDC of 1 tube



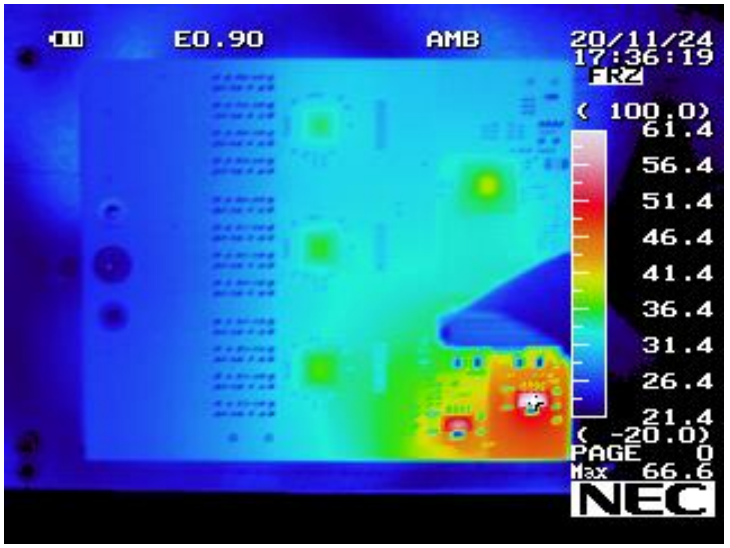
t ~ 760 ns

Temperature Studies

Old Mezz.



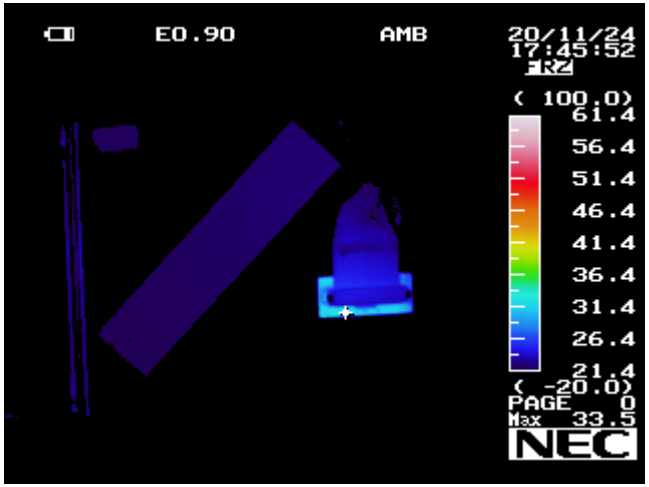
New Mezz.

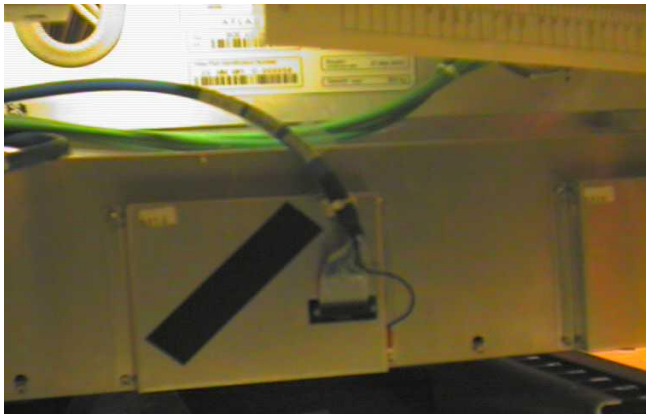


- Facility climatised: temperature moderated ≈ 21 ºC
- Hall temperature at the time of measurement: 20.1 ºC

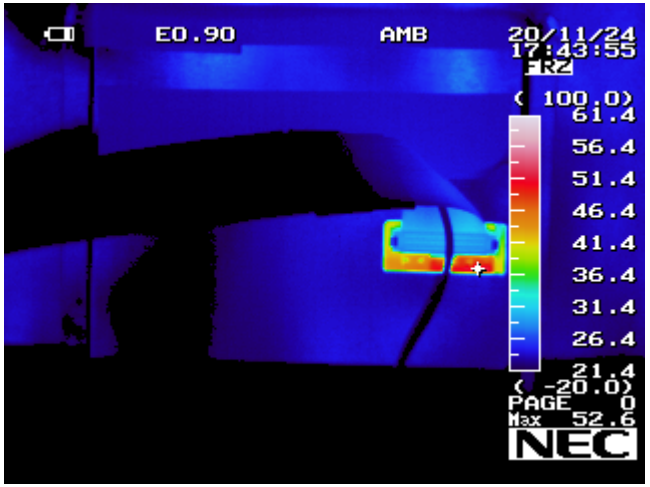
Temperature Studies

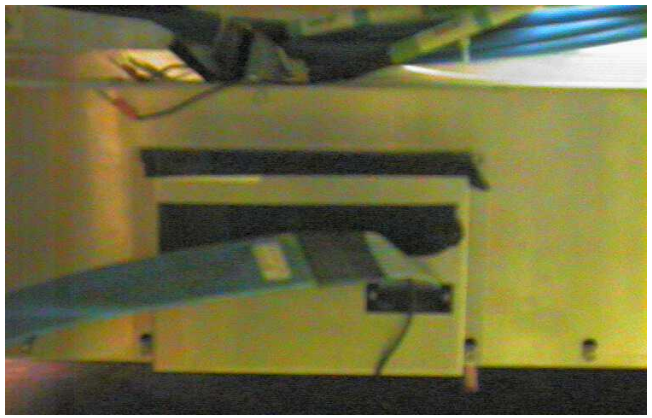
Old Mezz.





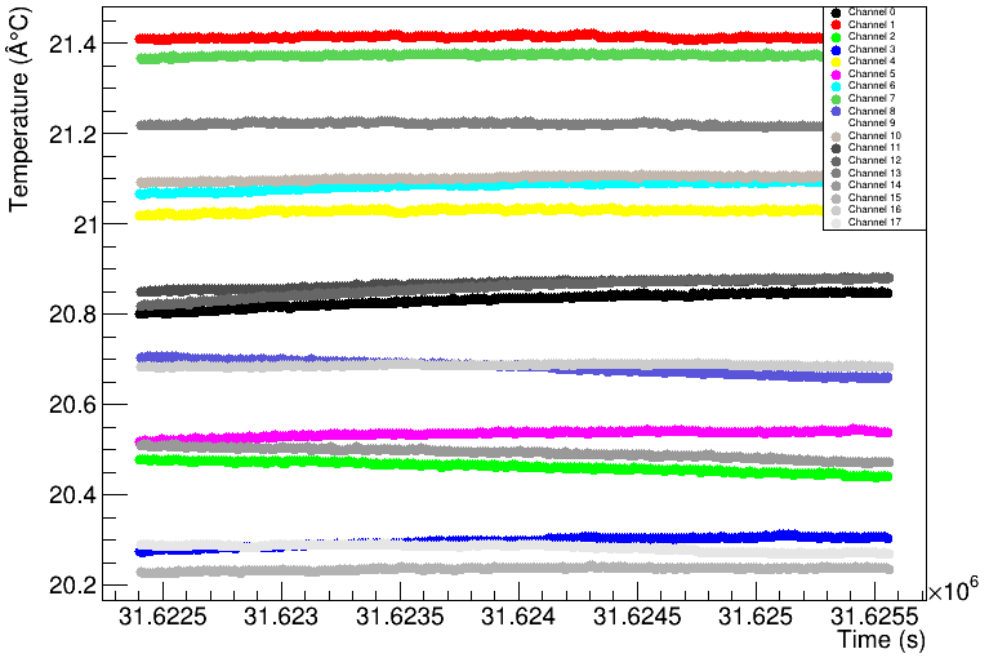
New Mezz.



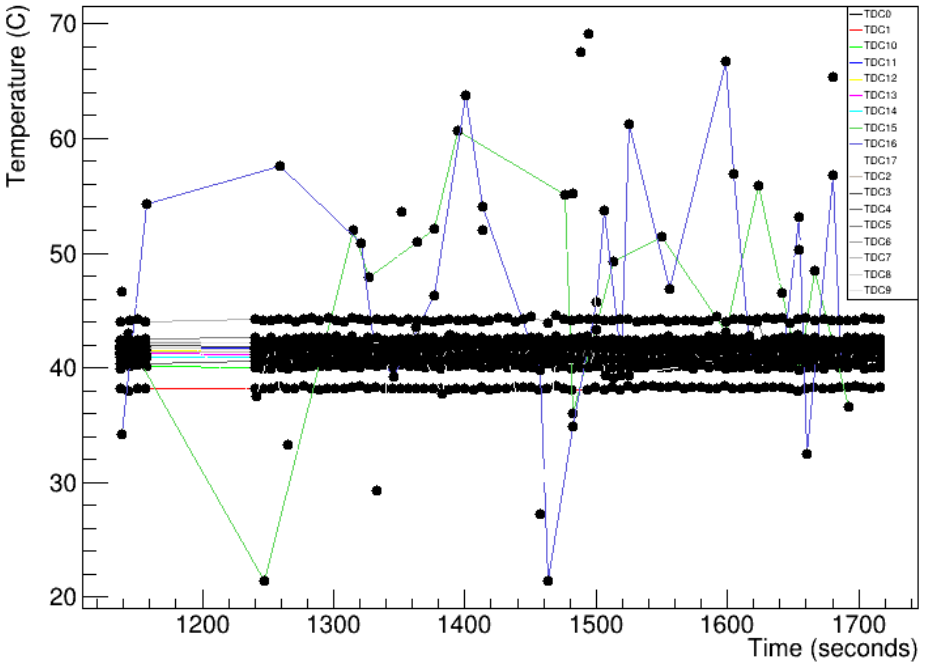


Temperature Studies

Old Mezz.



New Mezz.



- Facility climatised: temperature moderated at 21 ºC
- Position of temperature sensors influences the temperatures recorded

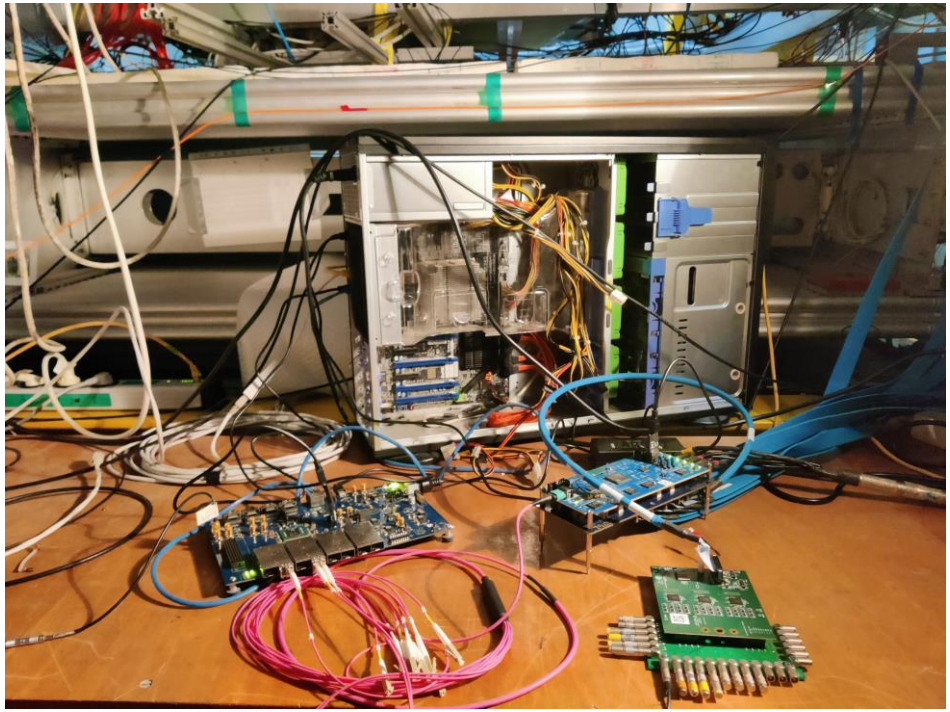
Summary and Outlook

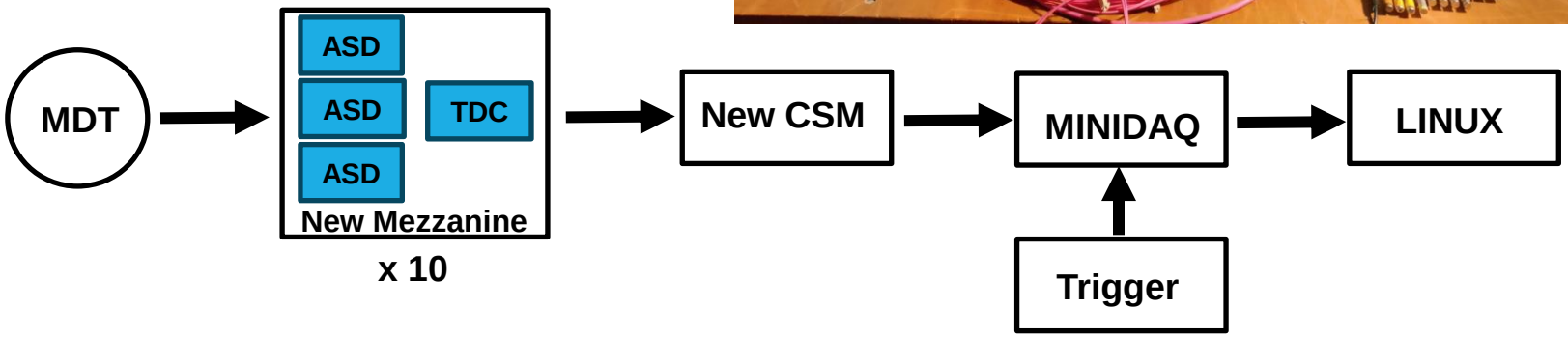
- LMU CRF consists of 2 spare MDT BOS chambers for tracking and scintillators for triggering
- ATLAS MDT Phase-II upgrade of the trigger and readout electronics is ongoing
- New FE electronics tested and measurements were successfully taken with one complete MDT chamber; matching spectra of TDC and ADC obtained
- Temperature studies of the mezzanines performed; stark differences between the new and old electronics observed
- On completion of the trigger and readout path upgrades to Phase-II, a full slice test of the electronics is planned

THANKS!

Current Test Set-up

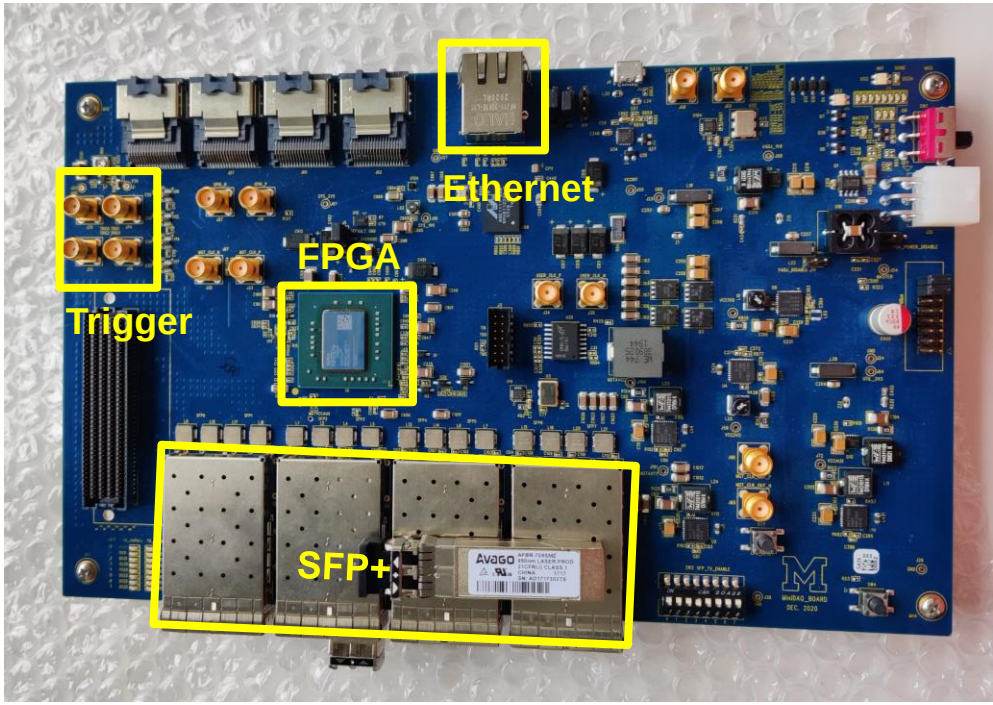
- HV of MDTs set to 3080 V
- MiniDAQ and CSM configuration successfully completed (many thanks to Yuxiang for the support!)
- Data with the old and new setup taken simultaneously to ensure same conditions





Backup: MiniDAQ Board

- Integration and testing of the FE electronics is very important
- It can be performed with the help of the MiniDAQ board: it is designed for sMDT/MDT chambers + FE electronics integration and commissioning
- It can handle atleast 2 CSMs, which is enough to readout the two whole MDT chambers



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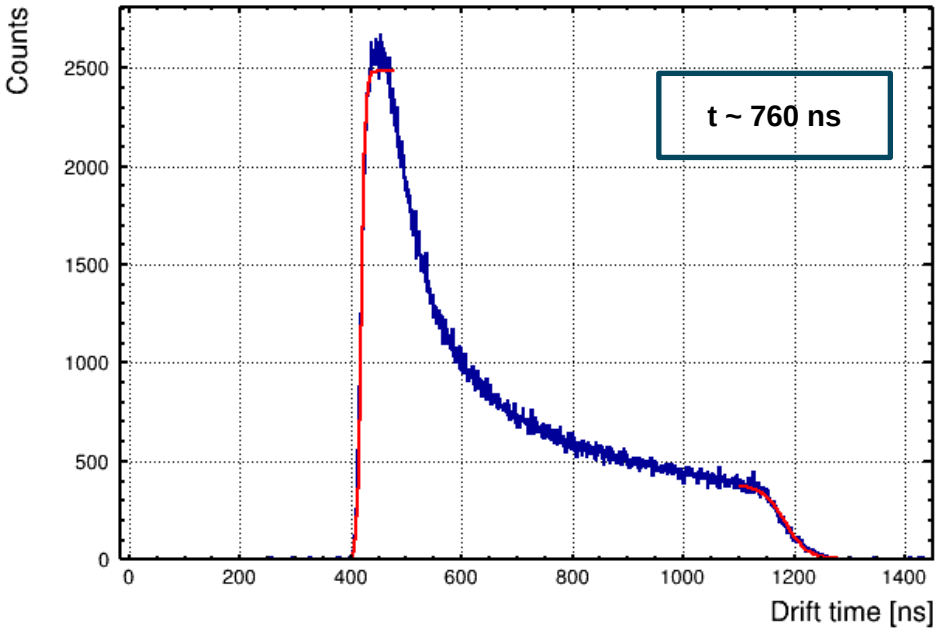

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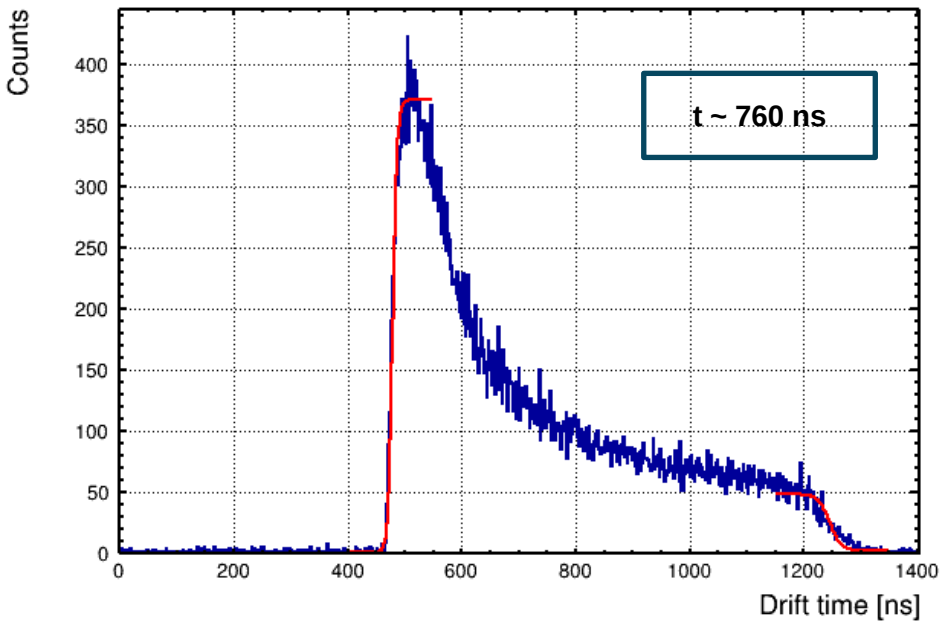
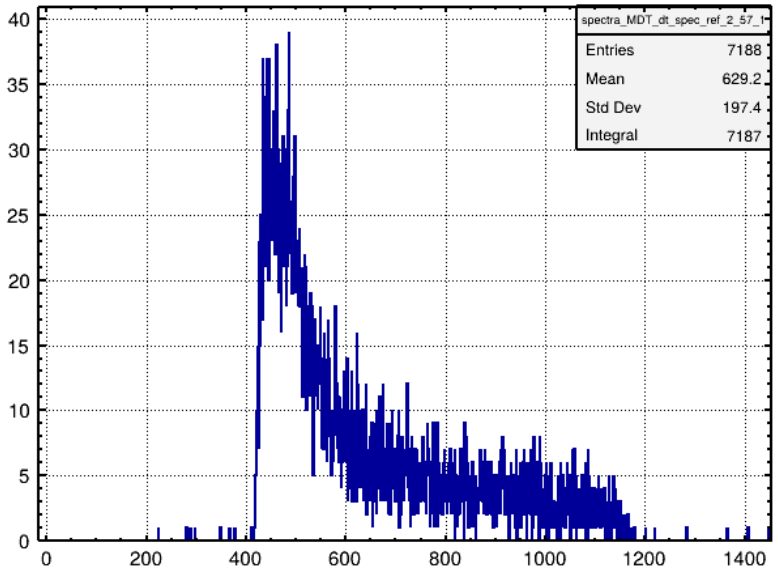


- TDC spectra compared between the legacy and new FE electronics
- Trigger matching performed inside the MiniDAQ FPGA

Data Comparison: TDC Spectra

Old ADC of 1 tube

New ADC of 1 tube



t ~ 760 ns